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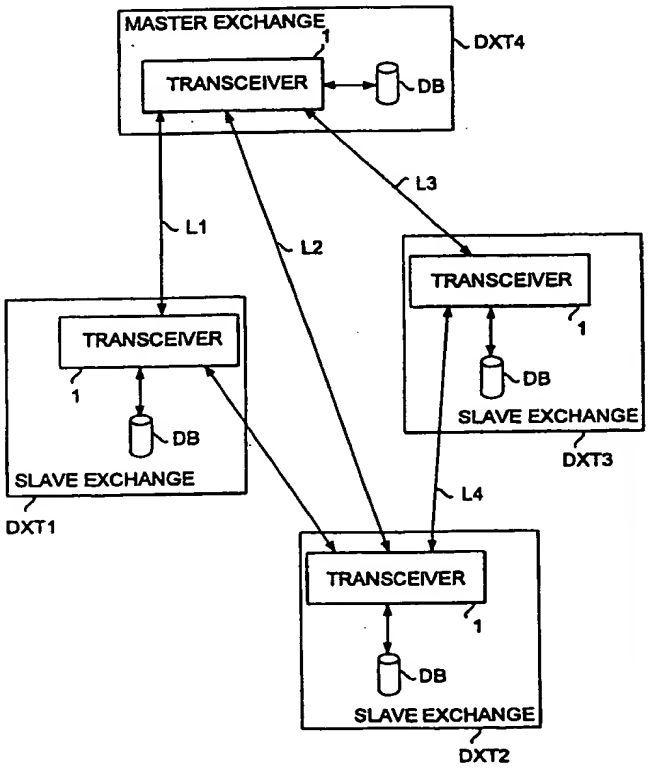
(54) Title: METHOD FOR DATA TRANSMISSION TO SLAVE EXCHANGES

(57) Abstract

The present invention relates to a method for a data transmission to several slave exchanges in a telecommunication system, the method in which the data is transmitted to the slave exchanges (DXT1 to DXT3) and an acknowledgement of the data reception is expected from the slave exchanges. To get a data transmission method which is more efficient and reliable than previously known methods, at least one slave exchange (DXT2) from which the acknowledgement is received is commanded to transmit said data to the slave exchange (DXT3) from which no acknowledgement is received, if one of the slave exchanges (DXT3) does not acknowledge the data reception.



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METHOD FOR DATA TRANSMISSION TO SLAVE EXCHANGES

The present invention relates to a method of a data transmission to several slave exchanges in a telecommunication system, in which method the data is transmitted to the slave exchanges and an acknowledgement is expected from the slave exchanges of a data reception. The method also relates to a telecommunication system comprising a master exchange and slave exchanges having a data transmission connection with the master exchange, and in which system the master exchange comprises transmitter means for transmitting data to the slave exchanges and receiver means for receiving acknowledgement messages from the slave exchanges, the slave exchanges comprise receiver means for receiving data transmitted by the master exchange and transmitter means for transmitting the acknowledgement messages to the master exchange in response to the data reception.

The invention relates particularly to the data transmission between exchanges of mobile communication systems, although the invention can also be applied in other connections. In the following, the invention is described by way of example with reference to the mobile communication systems in particular.

In mobile communication systems where several exchanges offer services to the same subscriber stations there is the need to transmit for example subscriber station information from one exchange to the other. Such a need for transmitting subscriber station information occurs for example in situations where the operator, or, alternatively, the subscriber himself changes settings regarding his subscriber station in the system. Thus, it must be possible to transmit said setting change to all the exchanges maintaining data concerning the settings of said subscriber station. If the data transmission to all the exchanges requiring the information fails, there is a risk of mutually inconsistent data concerning individual subscriber stations in databases in different exchanges.

In a previously known solution, the master exchange is arranged to transmit the changed data to all the slave exchanges requiring said data by utilizing a telecommunication connection between the master exchange and each slave exchange. Thus, the slave exchanges update the data in their databases to correspond with the new data received from the master exchange and acknowledge the reception of the new data to the master exchange. The most significant disadvantage of the known solution is that if the data trans-

mission connection between the master exchange and one of the slave exchanges is temporarily cut off, the updated data cannot then be transmitted to said slave exchange. Thus, the data in said slave exchange is inconsistent in regard to the data in other slave exchanges, and thus, different parameters may be stored for said subscriber station in different exchanges.

The object of the present invention is to solve the above mentioned problem and provide a method which is more efficient and reliable than previous methods for the data transmission to the slave exchanges. The object is achieved by the method of the invention characterized by commanding, in case one of the slave exchanges does not acknowledge the data reception, at least one slave exchange from which an acknowledgement is received to transmit said data to the slave exchange from which no acknowledgement is received if said at least one slave exchange has a connection with the slave exchange from which no acknowledgement is received.

The invention is based on the idea that when a telecommunication connection to one of the slave exchanges is cut off, other slave exchanges can be used as alternative distribution routes by transmitting data through some other exchange to the slave exchange from which no acknowledgement is received. The method of the invention can be applied without a prior knowledge about the manner in which the exchanges are connected with each other. Thus, the most significant advantages of the invention are that the data to the slave exchanges is delivered more reliably than before and that the use of the other slave exchanges as alternative distribution routes does not require a prior knowledge about the exchanges which are connected with each other in the system, since in accordance with the invention, all the slave exchanges can be commanded for example by turns to transmit the data to the slave exchange from which no acknowledgement is received until one of the slave exchanges finally succeeds in the data transmission. This enables the utilization of the slave exchanges in a very flexible manner, since for example when new exchanges are added to the system, the alternative distribution routes need not to be redefined.

The invention also relates to a system wherein the method of the invention can be applied. A telecommunication system of the invention is characterized in that the transmitter means of the master exchange are arranged to send a predetermined control message to at least one slave exchange having a data transmission connection with the master exchange if the

master exchange does not receive an acknowledgement message from one of the slave exchanges to which it has transmitted the data, and that the system comprises at least one slave exchange being responsible to the control message received from the master exchange for transmitting the data received from the master exchange to said slave exchange from which the master exchange has not received the acknowledgement message if said at least one slave exchange has a telecommunication connection with the slave exchange from which the master exchange has not received the acknowledgement message.

The preferred embodiments of the method and telecommunication system are disclosed in the dependent claims 2 to 4 and 6 to 10.

In the following, the invention will be described in more detail by means of a preferred embodiment of the invention with reference to the accompanying figures, of which

Figure 1 shows a flow diagram of a first preferred embodiment of the invention, and

Figure 2 shows a block diagram of a first preferred embodiment of the telecommunication system of the invention.

Figure 1 shows a flow diagram of a first preferred embodiment of the method of the invention.

In block A in Figure 1, updated data is transmitted to all the slave exchanges who require said data. A timer is switched on at the same time.

In block B, acknowledgements of the received data are received from slave exchanges.

In block C it is checked if the timer shows the expiration of the time reserved for the reception of the acknowledgements, i.e. if the time limit Tref is exceeded.

If the time reserved for the reception of the acknowledgements is exceeded, the routine proceeds to block D where it is checked if the acknowledgement is received of the data reception from all the slave exchanges to which the data was sent. If the acknowledgement is received from all the slave exchanges, the data transmission has been successful, and the routine proceeds to block K.

In contrast, if there is no acknowledgement from one of the slave exchanges, the routine proceeds through block E to block F where the data is

retransmitted to said slave exchange (or slave exchanges) from which no acknowledgement is received.

When the data has been retransmitted, the routine proceeds through block G to block H where one of the slave exchanges to which a data transmission connection exists, i.e. exchange n, is commanded to transmit the data to the slave exchange from which no acknowledgement is received. In accordance with the invention, it is not necessary to know in advance whether the slave exchange being commanded to transmit the data has a telecommunication connection with the slave exchange from which no acknowledgement is received. If no connection exists, the data transmission naturally fails, i.e. the acknowledgement is still not received.

In block I it is checked if the acknowledgement is received from the slave exchange from which no acknowledgement was received. If so, the routine proceeds to block K. If there is still no acknowledgement, the routine proceeds to block J where it is checked if all the slave exchanges to which a connection exists are commanded to transmit the data to the slave exchange from which no acknowledgement is received. If no, the routine returns to block F where the data is retransmitted after which the slave exchange next in turn to which a connection exists is commanded to transmit the data to the slave exchange from which no acknowledgement is received.

When all the slave exchanges to which a connection exists have been commanded once to transmit the data to the slave exchange from which no acknowledgement is received, the process is repeated, i.e. the first slave exchange is commanded to retransmit the data to the slave exchange from which no acknowledgement is received. According to the flow diagram in Figure 1, the process is repeated until the acknowledgement is received from all the slave exchanges. Alternatively, the data transmission can be attempted for a given period of time and if the data transmission fails, an alarm is given to the system operator.

In the flow diagram in Figure 1 it is assumed that the slave exchanges are commanded to transmit the data by turns to the slave exchange from which no acknowledgement is received and, at the same time, an attempt is made to transmit the data directly between each command. This is naturally only one alternative to apply the method of the invention. Alternatively, for example an attempt can be made to transmit the data first directly for a predetermined number of times to the exchange from which no acknowledgement is

received, after which all the exchanges to which a connection exists are commanded to transmit the data substantially simultaneously to the slave exchange from which no acknowledgement is received.

Figure 2 shows a block diagram of a preferred embodiment of the telecommunication system of the invention. The part of the telecommunication system presented in Figure 2 can be for example a part of the TETRA network (Trans-European Trunked Radio system), although the invention can also be applied in other connections.

A master exchange DXT4 in Figure 2 has a data transmission connection with slave exchanges DXT1 to DXT3 through data transmission connections L1 to L3. The master exchange DXT4 and the slave exchanges DXT1 to DXT3 can be totally identical TETRA network exchanges.

Databases DB in the exchanges DXT1 to DXT4 maintain data necessary for the operation of the system, such as group information. The group information contains information regarding one or several groups of subscribers who, for example, often need to communicate with each other. Said subscribers have been defined as members of the same group in the system. Thus, it is very easy to make for example group calls, i.e. calls that all the group members can hear. The group information for a single group can include for example:

- group identity
- a list of group members (for example a list of subscriber identities), and
- group area specification, i.e. information indicating the cells in the area of which the network supports the operation of the group.

The group information is always stored in the master exchange (i.e. in the home mobile telephone exchange of the group), and in addition, the information is copied to all the slave exchanges containing even a single cell in their area where the net supports the operation of the group.

In the case in Figure 2, the group information, i.e. the data, can be updated either in the master exchange DXT4 or in the slave exchanges DXT1 to DXT3 transmitting the updating to the master exchange DXT4 which, in turn, transmits the updating onward to other exchanges requiring said data.

In connection with the data updating, a transceiver unit 1 is arranged to transmit the data through the data transmission connections L1 to L3 to the slave exchanges DXT1 to DXT3 in the case in Figure 2. The transceivers 1 in the slave exchanges receive the data and store it in the databases

DB and acknowledge the data reception by an acknowledgement message to be sent to the master exchange.

If for example a telecommunication connection L3 is cut off in the system shown in Figure 2 when the master exchange DXT4 transmits the data to the slave exchanges DXT1 to DXT3 shown in Figure 2, the slave exchange DXT3 does not receive the data addressed to it. The transceiver unit 1 in the master exchange detects this by not receiving the acknowledgement from the exchange DXT3 within a predetermined time. The transceiver unit 1 in the master exchange then repeats the data transmission to the slave exchange DXT3, and in addition, the transceiver unit 1 in the master exchange sends a predetermined control message to the slave exchange DXT1 commanding by the control message the slave exchange DXT1 to transmit the data received from the master exchange to the slave exchange DXT3. Depending on the case, the data the slave exchange DXT1 must transmit to the slave exchange DXT3 can be included in the control message, or the slave exchange DXT1 can retrieve said data from its database DB on the basis of the control message.

Figure 2 shows that there is not a direct telecommunication connection between the slave exchange DXT1 and the slave exchange DXT3, whereby the slave exchange DXT1 cannot transmit the data received from the master exchange to the slave exchange DXT3. In accordance with the invention, the master exchange does not need information about the way the slave exchanges are connected with each other, but it systematically goes through all the slave exchanges with which it has a telecommunication connection, and commands them to transmit the data to that slave exchange from which it has not received the acknowledgement. In the above described case, the slave exchange DXT1 does not have a telecommunication connection with the slave exchange DXT3, and, thus, the data transmission fails. After a predetermined time from the transmission of the control message to the exchange DXT1, the master exchange detects that the acknowledgement from the slave exchange DXT3 is still not received. Then, the transceiver unit 1 in the master exchange DXT4 repeats the data transmission to the slave exchange DXT3, and in addition, the transceiver unit 1 in the master exchange sends the control message to the slave exchange DXT2 commanding by the control message the slave exchange DXT2 to transmit the data received from the master exchange to the slave exchange DXT3. Since the slave exchange DXT2 has a telecommunica-

tion connection L4 with the slave exchange DXT3 the data transmission to the slave exchange DXT3 is this time successful.

When a transceiver unit 1 in the slave exchange DXT3 has received the transmitted data it transmits the acknowledgement message by using the same route through which it received the data, i.e. through the slave exchange DXT2 to the master exchange DXT4. When the master exchange has received said acknowledgement message it stops data transmission attempts to the slave exchange DXT3.

It is obvious that the above description and the related figures are only intended to illustrate the present invention. Telecommunication systems also comprise other information besides the above mentioned subscriber information and group information presented by way of example, and to the transmission of which the present invention can be applied. A variety of modifications and variations will be apparent to those skilled in the art without deviating from the scope and spirit of the invention disclosed in the appended claims.

CLAIMS:

1. A method for data transmission to several slave exchanges in a telecommunication system, in which method the data is transmitted to the slave exchanges (DXT1 to DXT3) and an acknowledgement is expected from the slave exchanges of a data reception, **characterized** by

commanding, in case one of the slave exchanges (DXT3) does not acknowledge the data reception, at least one slave exchange (DXT2) from which an acknowledgement is received to transmit said data to the slave exchange (DXT3) from which no acknowledgement is received if said at least one slave exchange (DXT2) has a connection with the slave exchange (DXT3) from which no acknowledgement is received.

2. A method as claimed in claim 1, **characterized** by commanding each slave exchange (DXT1, DXT2), from which said acknowledgement is received, to transmit said data by turns to the slave exchange (DXT3) from which no acknowledgement is received until said slave exchange (DXT3) from which no acknowledgement is received acknowledges the data reception.

3. A method as claimed in claim 1, **characterized** by commanding substantially simultaneously all the slave exchanges (DXT1, DXT2) to which a telecommunication connection exists to transmit said data to the slave exchange (DXT3) from which no acknowledgement is received.

4. A method as claimed in any one of the claims 1 to 3, **characterized** by transmitting said data repeatedly to the slave exchange (DXT3) from which no acknowledgement is received, and by commanding the slave exchanges (DXT1, DXT2) from which the acknowledgement is received to transmit said data repeatedly to the slave exchange (DXT3) from which no acknowledgement is received until said slave exchange (DXT3) from which no acknowledgement is received acknowledges the data reception.

5. A telecommunication system comprising a master exchange (DXT4) and slave exchanges (DXT1 to DXT3) having a data transmission connection with the master exchange, and in which system

the master exchange (DXT4) comprises transmitter means (1) for transmitting data to the slave exchanges (DXT1 to DXT3) and receiver means (1) for receiving acknowledgement messages from the slave exchanges (DXT1, DXT2),

the slave exchanges (DXT1 to DXT3) comprise receiver means (1) for receiving the data transmitted by the master exchange and transmitter means (1) for transmitting the acknowledgement messages to the master exchange (DXT4) in response to the data reception, **characterized** in

that the transmitter means (1) in the master exchange (DXT4) are arranged to send a predetermined control message to at least one slave exchange (DXT2) having a data transmission connection with the master exchange if the master exchange does not receive the acknowledgement message from one of the slave exchanges (DXT3) to which it has transmitted the data, and

that the system comprises at least one slave exchange (DXT2) being responsible to the control message received from the master exchange (DXT4) for transmitting the data received from the master exchange (DXT4) to said slave exchange (DXT3) from which the master exchange has not received the acknowledgement message if said at least one slave exchange (DXT2) has a telecommunication connection (L4) with the slave exchange (DXT3) from which the master exchange has not received the acknowledgement message.

6. A system as claimed in claim 5, **characterized** in that the transmitter means (1) in the master exchange (DXT4) are arranged to send said control message after a predetermined time (Tref) from the data transmission if the master exchange has not received the acknowledgement message from one of the slave exchanges (DXT3).

7. A system as claimed in claim 5, **characterized** in that the master exchange (DXT4) is arranged to repeat the data transmission for a predetermined number of times to the slave exchange (DXT3) from which it has not received the acknowledgement message before sending said control message.

8. A system as claimed in claim 5, **characterized** in that having sent said control message the master exchange (DXT4) is arranged to retransmit the data repeatedly to the slave exchange (DXT3) from which no acknowledgement message is received until the master exchange (DXT4) receives the acknowledgement message from said slave exchange (DXT3) either directly or through some other slave exchange (DXT2).

9. A system as claimed in any one of the claims 5 to 8, **characterized** in that the master exchange (DXT4) is arranged to send said con-

trol message to all the slave exchanges (DXT1, DXT2) having a data transmission connection with it in case it does not receive the acknowledgement message from one of the slave exchanges (DXT3), and that said slave exchanges (DXT1, DXT2) receiving the control message are arranged to transmit the data received from the master exchange (DXT4) to said slave exchange (DXT3) from which the master exchange has not received the acknowledgement message in response to the reception of the control message if they have a data transmission connection with the slave exchange (DXT3) from which the master exchange (DXT4) has not received the acknowledgement message.

10. A system as claimed in claim 5, **characterized** in that said system is a telecommunication system and that said data consists of subscriber information in the system.

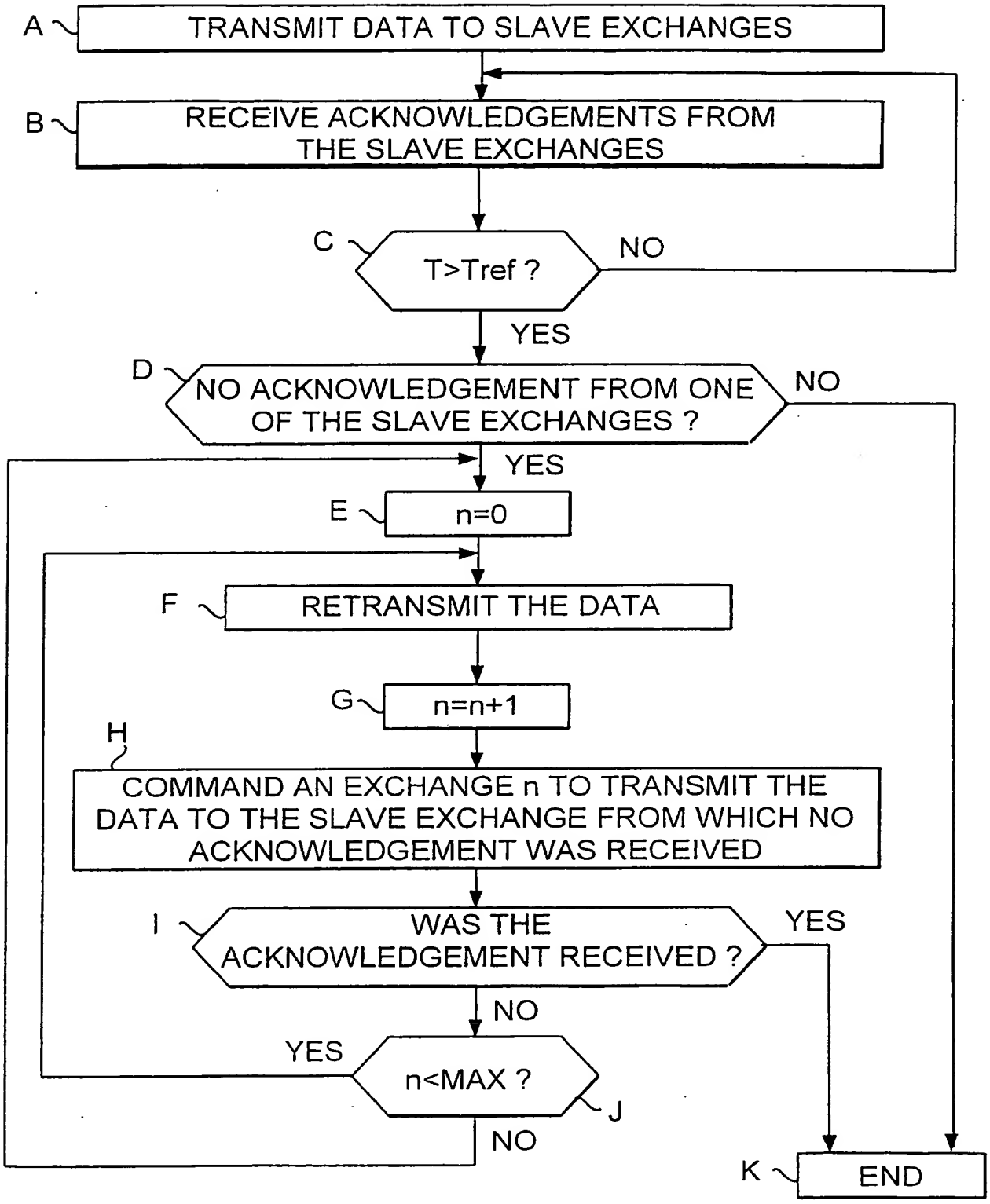
A
TRANSMIT DATA TO SLAVE EXCHANGES
B
RECEIVE ACKNOWLEDGEMENTS FROM THE SLAVE EXCHANGES
C
T>Tref ?
NO
YES
D
NO ACKNOWLEDGEMENT FROM ONE OF THE SLAVE EXCHANGES ?
NO
YES
E
n=0
F
RETRANSMIT THE DATA
G
n=n+1
H
COMMAND AN EXCHANGE n TO TRANSMIT THE DATA TO THE SLAVE EXCHANGE FROM WHICH NO ACKNOWLEDGEMENT WAS RECEIVED
I
WAS THE ACKNOWLEDGEMENT RECEIVED ?
YES
NO
YES
n<MAX ?
J
NO
K
END

FIG. 1

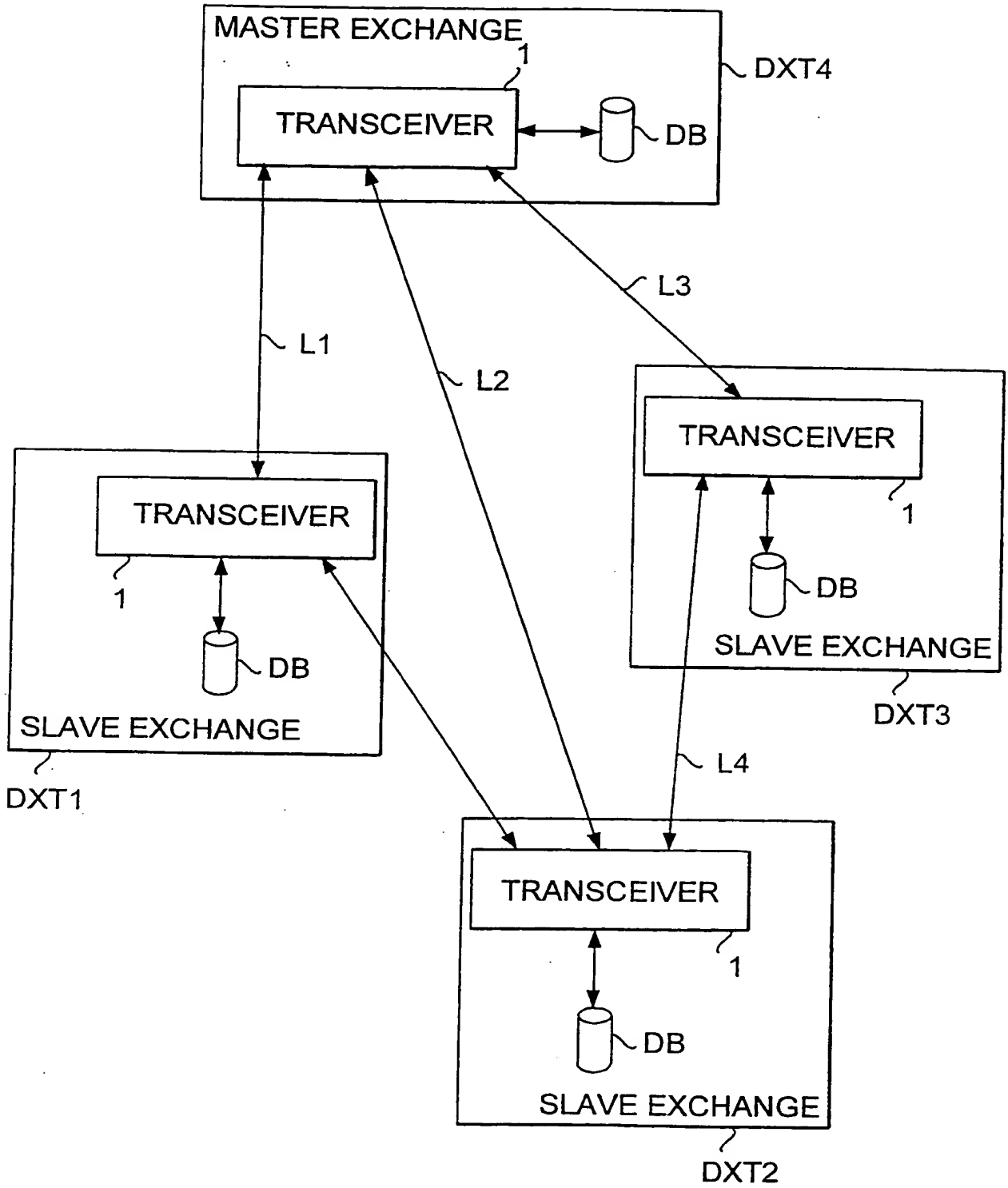
MASTER EXCHANGE
1
TRANSCEIVER
DB
DXT4
L1
L2
L3
L4
TRANSCEIVER
1
DB
SLAVE EXCHANGE
DXT3
TRANSCEIVER
1
DB
SLAVE EXCHANGE
DXT1
TRANSCEIVER
1
DB
SLAVE EXCHANGE
DXT2

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00036

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04L 1/18
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98/58469 A1 (QUALCOMM INCORPORATED), 23 December 1998 (23.12.98), page 8, line 17 - page 9, line 12	1-19
X	US 4439859 A (ROBERT A. DONNAN), 27 March 1984 (27.03.84), column 2, line 5 - line 48; column 9, line 59 - column 10, line 24	1-19
A	US 5664091 A (HENRY D. KEEN), 2 Sept 1997 (02.09.97), abstract	1-19
A	US 5610595 A (GARY W. GARRABRANT ET AL), 11 March 1997 (11.03.97), abstract	1-19

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98/43445 A2 (NOKIA TELECOMMUNICATIONS OY), 1 October 1998 (01.10.98), abstract -- --------	1-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.
PCT/FI 00/00036

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